NETL Life Cycle Inventory Data
Process Documentation File

Process Name: H2 from Biomass Gasification

Reference Flow: 1 kg of Hydrogen, >99.90 vol-%, 1,015 psia (6.99 MPa)

Brief Description: Energy use, feedstocks (including feedstock and water use), and emissions associated with gasification of biomass (hybrid poplar wood chips) to produce >99.9 vol-% hydrogen.

Section I: Meta Data

Geographical Coverage: United States **Region:** N/A

Year Data Best Represents: 2005

Process Type: Basic Process (BP)

Process Scope: Gate-to-Gate Process (GG)

Allocation Applied: No

Completeness: All Relevant Flows Recorded

Flows Aggregated in Data Set:

☒ Process ☒ Energy Use ☐ Energy P&D ☐ Material P&D

Relevant Output Flows Included in Data Set:

Releases to Air:	☒ Greenhouse Gases	☒ Criteria Air Pollutants	☒ Other
Releases to Water:	☐ Inorganic Emissions	☐ Organic Emissions	☐ Other
Water Usage:	☒ Water Consumption	☒ Water Demand (throughput)	
Releases to Soil:	☐ Inorganic Releases	☐ Organic Releases	☐ Other

Adjustable Process Parameters:

None.

Tracked Input Flows:

SRWC Biomass, harvested

[Technosphere] Wet biomass (50% moisture); hybrid poplar wood chips input, scaled to reference flow.

natural gas, delivered

[Technosphere] Natural gas input, scaled to reference flow.

Electricity, AC, 120 V

[Technosphere] Electricity input for facility operations, scaled to reference flow.

Water, purified

[Technosphere] Water filtered to acceptable purity by water treatment train.

Tracked Output Flows:

Hydrogen, >99.90 vol-%, 1,015 psia (6.99 MPa)

[Reference Flow]

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_O_H2_from_Biomass_Gasification_2022.01.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

This unit process provides a summary of relevant input and output flows associated with gasification of biomass (hybrid poplar wood chips) to produce hydrogen. The main reaction occurs in a low-pressure indirectly heated entrained flow gasifier followed by 11 sub-processes and is externally heated by natural gas. The reference flow of this unit process is: 1 kg of >99.9 vol-% hydrogen at 1,015 psia.

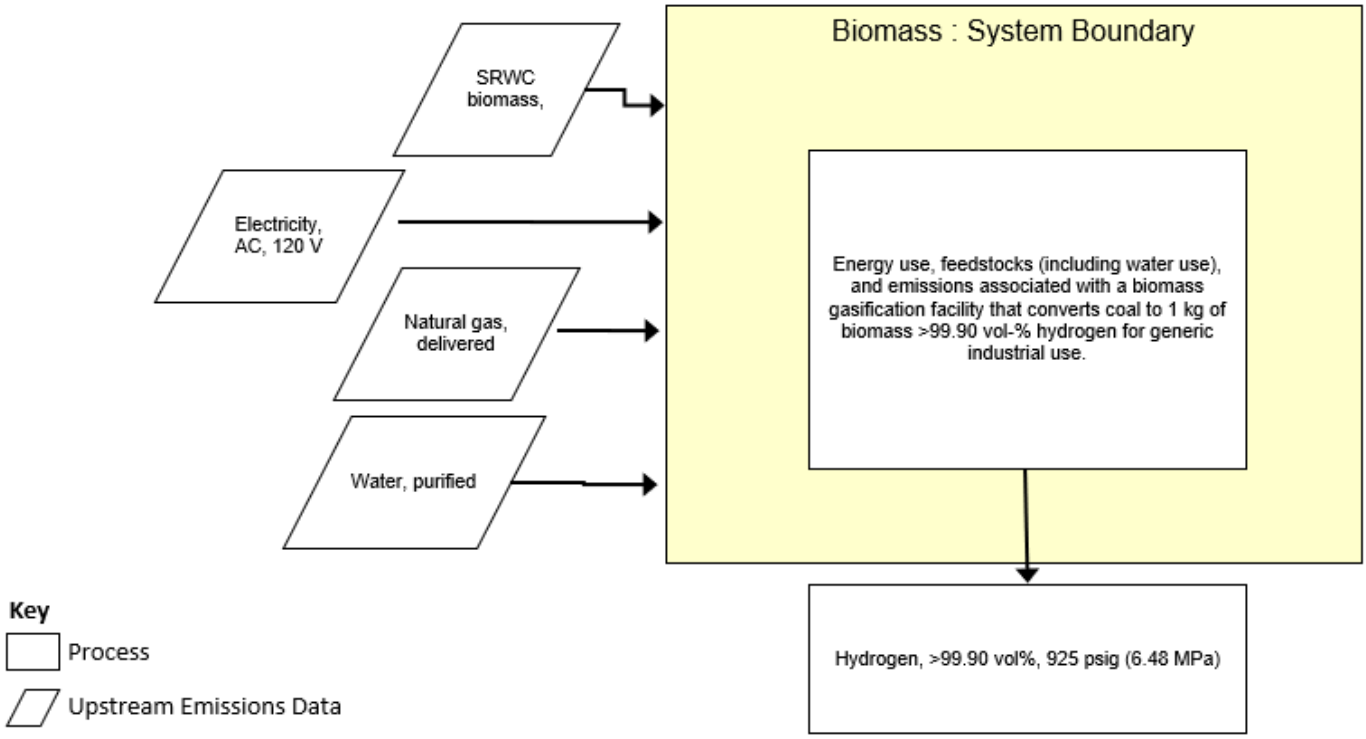
Boundary and Description

This unit process provides a summary of hydrogen production from gasification of biomass. Biomass gasification is a technology that thermochemically converts biomass and an oxidizing agent, such as air, oxygen, or steam into syngas, and ultimately hydrogen. Factors such as biomass type, reaction temperature, steam-to-biomass ratio, and presence of a catalyst can impact the efficiency of the system. The oxidizing agent used for gasification can be either air (inefficient), oxygen (expensive), or steam (seemingly preferred) (Lepage et al. 2020). One of the main concerns with biomass is its low hydrogen yield (6–12 wt-% H_2/kg biomass), but the abundance of available biomass feedstock makes up for this inefficiency (Al-Qahtani et al. 2021).

The material, energy, and emissions reported in this unit process are largely based on process data from the goal design case in a 2005 NREL report titled, Biomass to Hydrogen Production Detailed Design and Economics Utilizing the Battelle Columbus Laboratory Indirectly-Heated Gasifier (Spath et al., 2005). This report summarized a techno-economic analysis of a biomass gasification plant complete with process flow diagrams. The plant was broken down into 12 unit processes, though this profile is based on a mass and energy balance around the whole facility. The configuration modeled uses hybrid poplar wood chips with 50 wt-% moisture as feedstock and steam as the oxidizing agent. The main reaction occurs in a low-pressure indirectly heated entrained flow gasifier. Natural gas is used to provide heat to the plant and hydrogen is the only product from the process. Despite being published in 2005, this data is still representative of the biomass gasification process in the United States, as the process is relatively mature.

Inputs and outputs have been scaled to a reference flow of 1 kg of gaseous hydrogen at 1,015 psia and 43 °C.

Figure 1: Unit Process Scope and Boundary



Embedded Unit Processes

None.

References

Al-Qahtani, A., parkinson, B., Hellgardt, K., Shah, N., & Guillen-Gosalbez, G. Uncovering the True Cost of Hydrogen Production Routes Using Life Cycle Monetization. Applied Energy. https://doi.org/10.1016/j.apenergy.2020.115958

Lepage, T., Kammoun, M., Schmetz, Q. & Richel, A. Biomass-to-hydrogen : A Review of Main Routes Productiion, Process Evaluuation and Techno-Economical Assessment. Biomass and Bioenergy. https://doi.org/10.1016/j.biombioe.2020.105920

Spath, P, Aden, A, Eggeman, T, Ringer, M, Wallace, B, & Jechura, J. Biomass to Hydrogen Production Detailed Design and Economics Utilizing the Battelle Columbus Laboratory Indirectly-Heated Gasifier. United States. https://doi.org/10.2172/15016221

Section III: Document Control Information

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